rise to individuals of the fourth generation, and the germ-cells of these last individuals must contain eight different ancestral plasmas; similarly the germ-cells of the fifth generation must contain sixteen ancestral plasmas, and so on. It is thus clear that in a very small number of generations the composition of the germ-plasma must become extremely complicated: by the tenth generation it would already contain 1024 different ancestral plasmas.

We do not know how far this may go, because we do not know how small are the primary elements of germ-plasma, nor do we know how many of these elements may be indispensable for the youngest and smallest germ-cells. But if we imagine these elements to be excessively small, this process of doubling the number of ancestral plasmas in each generation must have come to an end after a certain number of generations, whether they were 10, 20, 100, or 1000!

From the time at which the germ-plasma first attained its utmost complexity further sexual propagation was only possible by halving the number of ancestral plasms contained in the germ-plasma. Clearly, this process of halving ought to take place in male germ-cells as well as in female ones, but at this moment we are only sure of its existence in the latter. We have seen that one-half of the germ-plasma contained in the nucleus of the egg-cell is expelled in the second polar cell. That the nuclear substance thus expelled is true germ-plasma, is not a mere supposition, but a certainty. We know of developing eggs which are either fertilized or unfertilized, and in the latter case they develop by parthenogenesis. Such are the eggs of the honey-bee. We may assume that if these eggs remain unfertilized they will expel only one polar globule, but that if, on the other hand, they are penetrated by a spermatozoon they will also expel the second globule. Thus the same idioplasma that is expelled from the fertilized egg remains, and forms half of the first segmentation-nucleus in the parthenogenetic egg. It must therefore be true germ-plasma.

I do not doubt that this is the true significance of the formation of a second polar globule. We can see the necessity on theoretical grounds for the removal of half the number of ancestral germ-plasmas; and we *actually* find that half of the germ-plasma *is* removed in every sexual egg.

If this reasoning be correct, our views on sexual propagation must undergo a total change. Fertilization is no longer an unknown impulse given to the egg-cell by the entrance of a spermatozoon, but it is simply the union of the germ-plasmas of two individuals. The spermatozoon is no longer the spark which kindles the powder, or the relatively small force which converts potential into actual energy, but it is merely the carrier of germ-plasma of a certain individual, possessing the necessary qualities for reaching, penetrating, and fusing with the bearer of germ-plasma from another individual. There are no *essential*, but merely individual, differences between the nuclear substance of the spermatozoon and that of the ovum. There are no such things as male or female nuclear substances, but merely male and female cells, carriers of the immortal germ-plasma. The differences are wholly individual and of merely secondary importance, and nothing corresponding to the ordinary notions implied by the terms male and female exists in germ-plasma.

If this be so, then it is clear that the fact of sexual propagation demands a new explanation. We must attempt to explain the reason why Nature has insisted upon the rise and progress of sexual propagation. If we bear in mind that in sexual propagation twice as many individuals are required in order to produce any number of descendants, and if we further remember the important morphological differentiations which must take place in order to render sexual propagation possible, we are led to the conviction that sexual propagation must confer immense benefits upon organic life. I believe that such beneficial results will be found in the fact that sexual propagation may be regarded as a source of individual variability, furnishing material for the operation of natural selection. I believe that sexual propagation has become prevalent among the higher organisms for the purpose of conserving and multiplying that individual variability which owes its first origin to the Protozoon condition of such higher organisms. But it is not now my purpose to speak further upon this subject: I have already discussed it elsewhere ("Die Bedeutung der sexuellen Fortpflanzung für die Selections-Theorie," Jena, 1886).

Whatever is to be said for the above hypotheses, the facts I have the honour of bringing before you to-day seem at least to prove that sexual propagation depends on the removal of half of the germ-plasma of the egg and the replacement of it by the same quantity of germ-plasma of another individual. This is now a fact which may be regarded as indisputable; and, further, the existence of true parthenogenesis is now proved beyond doubt. For we know now that an egg which expels only one polar globule enters without delay into embryonic development, inasmuch as it has retained the whole of its germ-plasma.

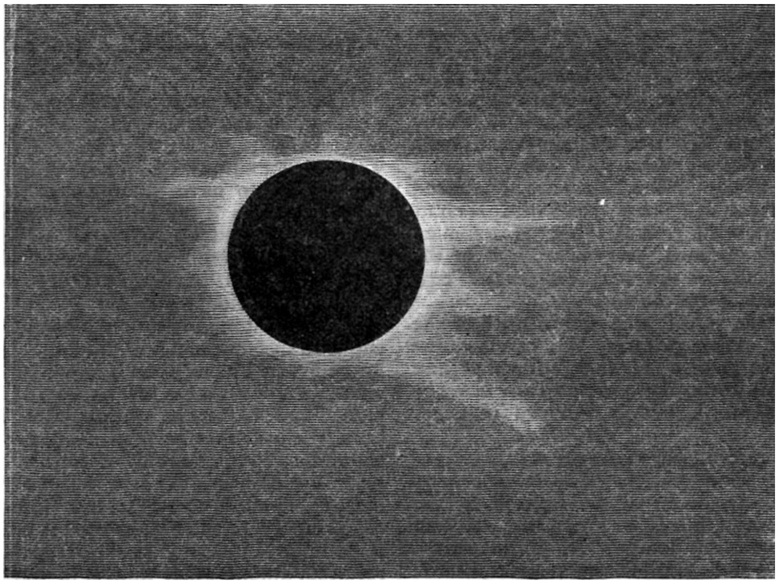
THE TOTAL ECLIPSE OF LAST AUGUST IN JAPAN.

THE eclipse has come and gone, and our little party is on its way home with a few papers and a small box of glass plates—a rather meagre showing for the hard work of our summer months. Although we were so unfortunate as to have uninterrupted cloud throughout the entire duration of the eclipse, our expedition to Japan has not been so dismal a failure all told. Apart from sundry observations of minor importance contributed by volunteer observers at scattering stations for whom I had prepared instructions, Dr. W. J. Holland, who joined the Expedition at my invitation as naturalist, has been actively engaged in botanical and entomological research in fruitful fields, and has a good harvest to report. He has also valuable notes upon his ascent of Nantaisan, Asama-yama, and Nasutake (which latter he appears to have been the first foreigner to ascend); while the separate expedition to the summit of Fuji-san (12,400 feet), which I had the pleasure to carry out under the auspices of the Boyden Fund of the Harvard College Observatory, and on which I had the highly-valued co-operation of Dr. E. Knipping, Meteorologist of the Japanese Weather Service, resulted, among other things, in the determination of its rare fitness as a site for astronomical observation—of which more elsewhere.

With reference to the preliminaries of the Eclipse Expedition it is necessary to state that early in the present year the trustees of the Bache Fund of the National Academy of Sciences, Washington, made a grant to Prof. Newcomb, the Superintendent of the *Nautical Almanac*, for observing the total solar eclipse of August 19, 1887. Prof. Newcomb determined the general lines of research to be undertaken, decided upon locating the observing-station in Japan, and placed me in charge of the Expedition. After some weeks of preparation in Washington and elsewhere, I set out for Japan on June 9, and arrived in Yokohama a month later. There was no small difficulty attending the definitive location of the instruments for observing the eclipse, owing to the deficiency of precise meteorological information regarding the region of the shadow-path. All existing data were kindly placed at my disposal by the officers of the Japanese Government, and several of the departments contributed in other ways to the assistance of an expedition which, had the skies been favourable, could not have failed of entire success.

Going northward from Tokio along the line of the Japanese Railway Company, to the courtesy of whose president, Mr. Narabara, our Expedition is deeply indebted, we pass through Utsunomiya at the distance of 65 miles, and at 113 miles reach Shirakawa, a town of about 10,000 inhabitants, and situate 10 or 12 miles north of the centre of the shadow-path. Here I found a spot forming, in many respects, an ideal location for an eclipse-station. Within a quarter of a mile of the telegraph-office and railway-station, and in an unfrequented part of the town, was the ruin of the celebrated old castle erected some 300 years ago, and occupied by the Abe family until the revolution of 1868. Permission to establish my station on the castle walls was given by Count Oyama, the Minister of State for the Army, under whose control this and similar castles elsewhere in Japan, formerly possessed by the Daimios, now are. The massive walls rise to a height of about 80 feet above the surrounding plain, and afford a capital foundation for the instrumental equipment—not to say the seclusion so desirable in the mounting and adjustment of delicate apparatus. Of the mountain-range 25 or 30 miles to the west and north-west, and its cloud-creating propensity, we had apparently little need for fear—in fact, a month's residence in the castle gave us a large proportion of afternoons on which an entirely satisfactory record of the eclipse in all its stages could have been secured.

Our main instrument was a horizontal photoheliograph of nearly 40 feet focal length, with which we hoped to expose 100 plates during the partial phases of the eclipse; but I had determined also to attempt coronal photography with the same instrument, hoping to obtain eight or ten negatives of the corona of such size that subsequent enlargement would be undesirable. At the focus of this telescope the sun's image has a diameter of 4½ inches, and dry plates 17 × 20 inches had been provided for this work. Also an extra mirror, finely silvered by Brashear, was taken along for the heliostat, to replace the unsilvered mirror ordinarily employed, shortly before totality came on. After the special modifications of the exposing-shutters and plate-holders had been made, and a light-proof tube or camera the whole length of the telescope had been constructed, periodic drill for the work of eclipse-day was at once begun. For some minutes immediately before the beginning and after the end of totality, the partial phase exposures were to be made every fifteen seconds, while the large plates for the corona, with exposures varying from one second to sixty-four seconds, were to be handled as rapidly as possible: we found that there was a loss of about five seconds between the plates, or something like one-sixth the entire duration of totality. With a very efficient photographic corps, and the drill which we all underwent, I had the best of reasons for anticipating complete success.



As was foreseen, too, we found in photographing artificial crescents—very slender ones—that no image of the plumb-line appeared on the plate; there was thus no initial line of reference for the measurement of position-angles. Mr. Hitchcock, whom I appointed photographer of the Expedition, undertook a variety of experiments to overcome this difficulty, and with entire success; the form of apparatus finally adopted will be detailed in the report of the Expedition. To assist in the operations of the photographic house, we were fortunate in securing the services of Mr. Ogawa, of Tokio, a Japanese photographer of wide experience, and Dr. Y. May King, of Amoy, also a highly-skilled manipulator.

As wet plates appeared to me preferable in many ways to dry ones for the partial phases, Mr. Hitchcock and Mr. Ogawa instituted a thorough series of experiments in the preservation of sensitized films, at first with glycerine, and subsequently more successfully with sugar. The results of this work made the wet plate, with its fine-grained film, as available for rapid manipulation in the photography of celestial phenomena as the dry plate has hitherto been found to be. It was shown that the plates might with entire safety be removed from the sensitizing bath from two to four hours before exposure and development, if treated with the sugar preservatives, and proper precaution was taken to keep the films from drying. The details of this process will be embodied in the report of the Expedition. As an extreme test we exposed, on the day after the eclipse, a box of the plates which had been sensitized and preserved for eclipse-work some twenty-six hours previously, and found that they gave sun-pictures photographically perfect.

In compliance with orders issued by the Secretary of the Navy, two officers from the Asiatic squadron, Lieut. Southerland and *Chief-Engineer Pemberton, of the* U.S.S. *Monocacy*, reported to me for eclipse-duty on my arrival in Yokohama, and their services were zealously and most effectively rendered. In addition to his work as executive officer, I placed Lieut. Southerland in charge of the 9-foot coronagraph, sent out by the Pickerings from the Harvard College Observatory. The objective of this instrument was the 7¼-inch Clark glass of the equatorial of my own Observatory at Amherst, while the dry plates, with the instructions for their manipulation, were identical with those furnished by the Pickerings to Prof. Young, who carried to his Russian station a 6⅝-inch Merz glass, also lent from the larger transit-instrument of Amherst College Observatory. I have not yet been able to learn whether Prof. Young was favoured with a clear sky during totality; but, if he was, it is the more regrettable that clouds covered the sun at Shirakawa, as the first serious attempt to obtain trustworthy evidence of rapid changes in the corona has thereby come to nought. It will be many a year before another eclipse occurs with two stations geographically so well placed for this special research as were Russia and Japan. Prof. Pickering desired me, if practicable, to place all or a portion of the corona-apparatus provided by this Observatory on the summit of one of the mountain-peaks of which there are several adjacent to the centre of the shadow-path, notably Nantaisan, 8500 feet high. Dr. Holland made the ascent of this mountain about the middle of July; but his report of its difficulties, together with the highly probable cloudy condition of the summit during the eclipse, led me to abandon farther consideration of this mountain; while the other peaks were too far removed from Shirakawa to permit of occupation with the time and assistance at my disposal. The remainder of Prof. Pickering's apparatus was therefore mounted alongside the photoheliograph at the central station; the double coronagraph, two 5-inch lenses of about 3 feet focus, being operated by Dr. Ames, U.S. Navy, while Dr. D. B. McCartee attended to the exposures with the 4-inch short-focus camera, and Mr. C. R. Greathouse to the exposures of plate-holders for determining the actinic effect of the coronal light.

The valued service of Mr. Pemberton is worthy of special mention here in rendering the photoheliograph less unwieldy for rapid work than I had found it formerly. By means of an ingeniously-devised system of cords and pulleys, led from the heliostat into the photographic house, the reflecting mirror was placed under the immediate and constant control of the chief astronomer making the exposures: it was thus possible to dispense with the customary assistant at the heliostat pier for adjusting the mirror in right ascension and declination. A very simple device made it possible to see the bright reflected image of the sun while at my post in the dark room, and adjust it accurately on the plate without opening the exposing-slide.

The importance of Newcomb's and Langley's observations of the outer corona in 1878, and attempted by Lockyer in 1886, had not escaped me, and I had an occulting-disk mounted on a rod attached firmly to the gable of the photographic house, so that its shadow as cast by the eclipsed sun would fall about 50 feet away, in the area inclosed by the upper castle wall. Here I stationed Mrs. Todd, provided with all the paraphernalia for seeing and sketching in their correct relations the faint outlying streamers of the corona.

Of two 3½-inch telescopes lent by Admiral Yanagi, Hydrographer of the Imperial Japanese Navy, one was reserved for the optical observation of first and fourth contacts, and the search for intra-Mercurial planets; while the other was committed to Dr. Holland, a skilled artist, with instructions to sketch as far as possible all the details of the corona adjacent to the solar poles.

Mr. Nakagawa, the Director of the Naval Observatory, with his assistant, made a thorough series of meteorological observations throughout the eclipse period, following the system elaborated by Von Bezold and recommended by the German Meteorological Conference for the observers in Russia. On the north-west corner of the castle wall I stationed Mr. K. Açino, a student of astronomy in the University, to make detailed and precise observations of the diffraction bands, and to observe if possible the sweep of the lunar shadow across the extensive rice-fields below.

The purely eclipse results of the work at Shirakawa were disheartening in the extreme. The forenoon gave us a perfect sky, with no indication whatever of approaching cloud: all were confident of entire success. But about an hour before the time of first contact, a slender finger of cloud began to rise from the west, coming at first directly above the summit of Nasutake, a volcano about 25 miles away, and which had sprung into unwonted activity during the past night, belching forth for hours enormous volumes of smoke and steam. The sun was entirely invisible during the first half-hour of the eclipse, when a brief interval of partly clear sky gave time for adjusting the heliostat and making ten or twelve exposures. The sun being very faint, only five of these photographs are available for measurement; and these were the only pictures that could be taken with the photoheliograph. The dense clouds, leaving a large clear area most of the time about the zenith, lay over the sun until the eclipse was past, save only a moment shortly after totality, when there was a partial clearing, but too brief, and the sun too faint, to allow of the necessary adjustment of the reflecting mirror.

As totality drew near, it suddenly occurred to me that a good observation of second contact might be possible by watching for the approach of the moon's shadow among the clouds; but my attempt to do this failed, the light appearing to me too much diffused to permit of anything better than a rough approximation to the time of contact. I found subsequently among Mrs. Todd's notes of the eclipse that totality appeared to her to come on, not evenly, but as if by jerks—a phenomenon which may, I think, have been due to the extinction of the sun's light from one cloud after another, as the lunar shadow advanced over the north-western sky. The weather-map for August 19, which came to our station from Tokio the day after the eclipse, gave us some idea of the odds we had been labouring against: the sheet for 2 p.m. showed clouds at all stations of the Meteorological Service except one, and that far removed from the belt of totality. In general, the whole of the main island was obscured on the eventful afternoon, and a view of the eclipse was permitted only to those so fortunate as to be located in the line of the small apertures, here and there, through the general cloud area. These were numerous enough to enable voluntary observers, scattered over the central portion of the belt of totality, and for whom I had prepared instructions, to obtain a goodly number of drawings of the corona. These instructions had been translated into Japanese, and printed and distributed through the co-operation of the Department of Education and the Bureau of Geography of the Department of the Interior. Altogether there are something like a hundred such drawings; but their value is uncertain until they are properly collated. Much the best drawing which I saw was made by Mr. Shuji Isawa, Chief of the Bureau of Compilation of the Department of Education, who was fortunate enough to be located in a spot in Western Japan, where totality was seen in a nearly cloudless sky. He has kindly furnished me with photographs of his drawing, one of which is inclosed.

Other Expeditions in Japan fared ill also—some of them worse than my own. That sent out from the University in charge of Prof. Terao, and located a few miles south of Shirakawa, at Kuroiso, experienced not only heavy clouds, but much rain during the eclipse, and no observations could be made. At Sanjo, on the central line and south-east of Niigata, Prof. Arai, Director of the Meteorological

Observatory, was able to make successful exposures for the corona with a small telescope. It was reported clear during the whole eclipse at Choshi, a point on the eastern coast near the southern limit of total obscuration, but there were no observers or instruments there for scientific work. It was reported cloudy throughout the whole eclipse at Niigata; while a party of observers who had ambitiously climbed to the top of Nantaisan brought down a record of nothing but clouds and fog. On the whole, Japan appears to have been an uncanny spot to lead an eclipse-track across. DAVID P. TODD.

s.s. *Port Victor*, September 20.

THE MÄRJALEN SEE.

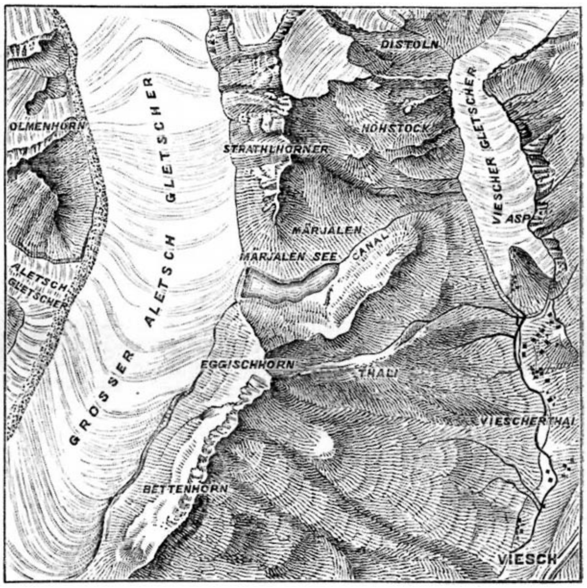
LAKELETS, in which the ice-crags of a glacier are mirrored, in which miniature bergs may be seen to float, are of occasional, though of rare, occurrence in the Alps—as for example the Lac de Ste. Marguerite, at the foot of the Ruitor glacier; but the Märjalen See, so far as I know, is unique of its kind. It is not formed at the foot of a glacier, either by partial occupation of a shallow basin worn by the ice-stream in its days of greater strength, or by the pounding back of the glacier torrent by an old terminal moraine; but it is on one side of a glacier, which makes a dam across an upland glen. This barrier at times yields to the pressure of the accumulated water sufficiently to allow of its escape beneath the great ice-stream, and it is a recent incident of the kind, noticed in the *Times* of September 30, which has suggested the present article.

The Great Aletsch glacier, as is well known, is the largest ice-stream not only in the Oberland group, but also in the Alpine chain. Its upper basin is fed by the snows of an almost complete ring of grand peaks, the most conspicuous of which, enumerated from west to east, are the Aletschhorn, the Jungfrau, the Mönch, and the Viescherhörner. All these are considerably above 13,000 feet, and there are several others, less familiar to the ordinary tourist, which either rise slightly above that elevation, or are only a very few hundred feet below it. The great *eismeer* thus formed passes out as a single stream through a "gate in the hills," between the crags of the Faulberg on the east and the base of the Dreieckhorn on the west. This gap is rather more than a mile across, and the glacier for several miles is not less, and is generally rather more, than its breadth at this place. It flows at first slightly to the east of south, then runs almost due south, and finally sweeps gradually round to the south-west. This deflexion is caused by the Eggischhorn, which rises like a great pyramid full in face of the upper course of the glacier to a height of 9649 feet above the sea, or nearly 2000 feet above the surface of the ice. At this spot the Märjalen See is situated, at a height of 7710 feet above the sea, rather less than five miles below the "gate," and rather more than that distance above the end of the Aletsch glacier. This sweeps on along the west flank of the Eggischhorn, until it terminates in the grand gorge of the Massa, at no great distance from the Bel Alp Hotel, a worthy rival in beauty of situation to that on the Eggischhorn.

The Märjalen See is thus formed: the range of the Eggischhorn is continuous with that which makes the left bank of the Aletsch glacier, and divides its comparatively unbroken surface from the narrower and more shattered mass of the Viesch glacier. But this range to the north of the Eggischhorn is deeply notched, so that it is possible to quit the Aletsch glacier and without ascending to reach a depression, barely so high as the surface of the ice, from which one looks down a steep slope on to the surface of the Viesch glacier. From this depression a shallow valley descends towards the west, and is barred, as mentioned above, by the great glacier of the Aletsch. Thus a lake is formed, fed by various streamlets from the slopes on either side and by the melting of the glacier ice. Though now the shrunken stream of the Aletsch glacier does not diverge towards the lake, it was no doubt formerly divided by the opposing mass of the Eggischhorn; then one of its arms occupied the bed of the lake, and after passing over the depression joined itself to the Viesch glacier. Some geologists regard the basin of the Märjalen See as wholly due to the excavatory action of this offshoot of the Aletsch. To myself it appears to be the upper part of a valley, produced in the ordinary way, but subsequently modified in its outlines by the rasping action of the glacier.

At somewhat irregular intervals, but according to popular belief once in seven years, the ice-dam yields sufficiently to allow the pent-up waters to escape beneath the glacier, when the contents of the lake are discharged rapidly down the gorge of the Massa, and, after devastating the fields below, are poured into the Rhone, near Brieg.

In the summer of 1858 I had the good fortune to see the Märjalen See both full and empty. On my first visit I found a lake full 300 yards across at the lower end, and about three times as long. From the rocky margin on either side the ice arched up in a low flattened curve until its edge at the highest point was about 60 feet [1] above the level of the water. From this it rose in a vertical cliff of almost unbroken ice, of purest white, which was mirrored in the still blue water below. Here and there miniature icebergs were floating, in colour if possible yet purer than the parent glacier, and above the water at the foot of the cliff was a band of turquoise blue. This was produced by the fresh surface of the ice, for the cliff is under-cut by the action of the water of the lake, and to this undercutting the bergs are no doubt partly due.



Next evening I revisited the spot. To my surprise all was changed: the lake had almost wholly disappeared; the glacier cliff which the day before had been doubled by reflexion, was now doubled in reality. Below the upper zone of white ice was now a zone of more than

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[1] Probably the height at the present time is not so great. Since 1858 there has been a considerable shrinking in the glaciers of the Alps. When I visited the Märjalen See in 1881, the greatest height of the cliff did not appear to me to exceed 30 feet. In 1858 Prof. Ramsay found by measurement that the greatest height of the cliff above water was 60 feet, and the greatest depth of the lake at its foot 97 feet ("Peaks, Passes, and Glaciers," 1st series, p. 461).